BDM SUBCONTRACT FACT SHEET

CONTRACT TITLE: Research and Development of Naturally Fractured Reservoirs: Optimized E&P Strategies Using a Reaction-Transport-Mechanical Simulator in an Integrated Approach

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CONTRACT PERFORMANCE PERIOD

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FUNDING (1000's)	BDM SHARE	OTHER SHARE	TOTAL
PRIOR FISCAL YRS	484	271	**755**
FISCAL YR 1998	264	0	**264**
FUTURE FUNDS	0	0	**0**
TOTAL EST'D FUNDS	**748**	**271**	**1,019**

PROJECT DESCRIPTION:

The class of reservoirs to be addressed are common in the Permian Basin and throughout the United States. In most cases they produce oil from fractures that result from a mixture of tectonism and diagenesis. The latter is often responsible for the creation of matrix and vuggy porosity which may later compromise rock strength and lead to a network of small-scale fractures around and often connecting vugs. As exploration, field development and production require a knowledge of the spatial distribution of these factors in as much as they effect reservoir characteristics, it would be a great advantage to improve a quantitative model that combines geochemistry and geomechanics with geological and production data to most effectively exploit these resources. This project will test and evaluate such a code and integrated approach.

Accomplishments:

A number of unique and very promising new technologies for basin/reservoir modeling-based prediction of fracturing in petroleum reservoirs have been developed. These technologies are being tested in the Permian Basin (West Texas). The sum total of these advances will, upon integration with observation-based approaches, usher in a new level of fractured reservoir predictability.

This project has taken a multi-disciplinary approach to creating a sophisticated numerical model that permits the quantification of the characteristics of fractured carbonate reservoirs. The study focuses on PPC's Andector Field, the largest Ellenburger producing field in the Permian Basin, in which production is dominated by natural fractures. An advanced reaction, transport, mechanical, mathematical modeling and computer code are used to assess the extent of reservoir producibility predictions and the evolution of these dynamic petroleum systems through time. The accuracy of the predictions and their value in optimizing and developing E&P strategies and field operations are being evaluated. The research team is aggressively transferring technology to other operators working in the Permian Basin and on similar reservoir types throughout the world.

Geological and geophysical data were collected to provide the boundary conditions (overall sedimentary, tectonic and basement heat flux histories) of the region. Specific data sets include stratigraphic composition and regional lateral shortening structures and tectonic model. While these geological and geophysical constraints were collected and synthesized, IU-LCG's CIRF.B code was improved to more accurately take into account the fracture dynamics of vuggy carbonate rocks, more complex multi-phase pore fluid flow, and more sophisticated rheologic equations controlling fracture genesis and rock deformation in carbonate rocks. With this, the magnitude of stress and deformation throughout the modeling region can be more accurately predicted by CIRF.B.

Following this code improvement, numerous calibration runs have been made using Permian Basin (and in particular, PPC engineering) data. As part of this process, additional geologic and geophysical data requirements have been identified, collected and synthesized for model input and testing.

The significance of vug-related microfracturing in order to qualitatively assess their importance on production has been evaluated. CIRF.B is being modified to permit the direct input of reservoir production data and the dynamics of a waterflood program in the reservoir. When complete, the effect of production on the local stress regime in the reservoir, and the effect of the changing stress state on production from fracture systems will be determined. This will allow the calculation of the production-induced increase in effective stress on the reservoir fractures. While the stress-sensitive nature of these fractured carbonate reservoirs has been suggested earlier, no quantitative assessment of the stress sensitivity has ever been conducted that accounts for the dynamics of reservoir mechanics, hydrology, geochemistry and rock texture.

The upgrading of CIRF.B for carbonate fractured reservoir modeling represents a major advance in our ability to use conventional subsurface geologic and geophysical information to make quantitative predictions of fracture location and characteristics across a basin or reservoir. The ability to quantitatively understand and predict these critical controls on reservoir properties and their evolution over time (including the producing life of the field) will allow industry to more efficiently design engineering programs that maximize the recovery efficiency of fractured carbonate reservoirs throughout the globe.